

GPM MISSION OVERVIEW AND U.S. SCIENCE STATUS

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Abstract

The Global Precipitation Measurement (GPM) Mission is an international satellite mission to unify and advance precipitation measurements from a constellation of research and operational sensors to provide “next-generation” precipitation products [1-2]. Water is fundamental to life on Earth. Knowing where and how much rain and snow falls globally is vital to understanding how weather and climate impact both our environment and Earth’s water and energy cycles, including effects on agriculture, fresh water availability, and responses to natural disasters. Since rainfall and snowfall vary greatly from place to place and over time, satellites can provide more uniform observations of rain and snow around the globe than ground instruments, especially in areas where surface measurements are difficult. Relative to current global rainfall products, GPM data products will be characterized by: (1) more accurate instantaneous precipitation measurements (especially for light rain and cold-season solid precipitation), (2) more frequent sampling by an expanded constellation of domestic and international microwave radiometers including operational humidity sounders, (3) inter-calibrated microwave brightness temperatures from constellation radiometers within a unified framework, and (4) physical-based precipitation retrievals from constellation radiometers using a common *a priori* cloud/hydrometeor database derived from GPM Core sensor measurements.

The cornerstone of the GPM mission is the deployment of a Core Observatory in a unique 65° non-Sun-synchronous orbit to serve as a physics observatory and a reference standard to unify precipitation measurements by a constellation of dedicated and operational passive microwave sensors. The design of the GPM Core Observatory is an advancement of the Tropical Rainfall Measuring Mission (TRMM)’s highly successful rain-sensing package. The Core Observatory will carry a Ku/Ka-band Dual-frequency Precipitation Radar (DPR) and a multi-channel (10-183 GHz) GPM Microwave Radiometer (GMI). Since light rain and falling snow account for a significant fraction of precipitation occurrence in middle and high latitudes, the

GPM instruments extend the capabilities of the TRMM sensors to detect falling snow, measure light rain, and provide, for the first time, quantitative estimates of microphysical properties of precipitation particles. The combined use of DPR and GMI measurements will place greater constraints on possible solutions to radiometer retrievals to improve the accuracy and consistency of precipitation retrievals from all constellation radiometers.

The GMI uses 13 different microwave channels to observe energy from the different types of precipitation through clouds for estimating everything from heavy to light rain and for detecting falling snow. As the satellite passes over Earth, the GMI constantly scans a region 885 kilometers across. The Ball Aerospace and Technology Corporation built the GMI under contract with NASA Goddard Space Flight Center. The DPR provides three-dimensional information about precipitation particles derived from reflected energy by these particles at different heights within the cloud system. The two frequencies of the DPR also allow the radar to infer the sizes of precipitation particles and offer insights into a storm's physical characteristics. The Ka-band frequency scans across a region of 125 kilometers and is nested within the wider scan of the Ku-band frequency of 245 kilometers. The Japan Aerospace and Exploration Agency (JAXA) and Japan's National Institute of Information and Communications Technology (NICT) built the DPR.

The Core Observatory satellite will fly at an altitude of 253 miles (407 kilometers) in a non-Sun-synchronous orbit that covers the Earth from 65°S to 65°N — from about the Antarctic Circle to the Arctic Circle. The GPM Core Observatory is being developed and tested at NASA Goddard Space Flight Center. Once complete, a Japanese H-IIA rocket will carry the GPM Core Observatory into orbit from Tanegashima Island, Japan in 2014.

The GPM constellation is envisioned to comprise 8 or more microwave sensors provided by partners, including both conical imagers and cross-track sounders. GPM is currently a partnership between NASA and the Japan Aerospace Exploration Agency (JAXA). Additional partnerships are under development to include microwave radiometers on the French-Indian Megha-Tropiques satellite [3] and U.S. Defense Meteorological Satellite Program (DMSP) satellites [4], as well as humidity sounders or precipitation sensors on operational satellites such as the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP), NOAA-NASA Joint Polar Satellite System (JPSS) satellites, European MetOp satellites, and DMSP follow-on sensors [5-6]. In addition, data from Chinese

[7] and Russian [8] microwave radiometers may be available through international cooperation under the auspices of the Committee on Earth Observation Satellites (CEOS) and Group on Earth Observations (GEO).

GPM's next-generation global precipitation data will lead to scientific advances and societal benefits in the following areas:

- Improved knowledge of the Earth's water cycle and its link to climate change
- New insights into precipitation microphysics, storm structures and large-scale atmospheric processes
- Better understanding of climate sensitivity and feedback processes
- Extended capabilities in monitoring and predicting hurricanes and other extreme weather events
- Improved forecasting capabilities for natural hazards, including floods, droughts and landslides.
- Enhanced numerical prediction skills for weather and climate
- Better agricultural crop forecasting and monitoring of freshwater resources.

An overview of the GPM mission concept and science activities in the United States, together with an update on international collaborations in radiometer intercalibration and ground validation, will be presented.

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